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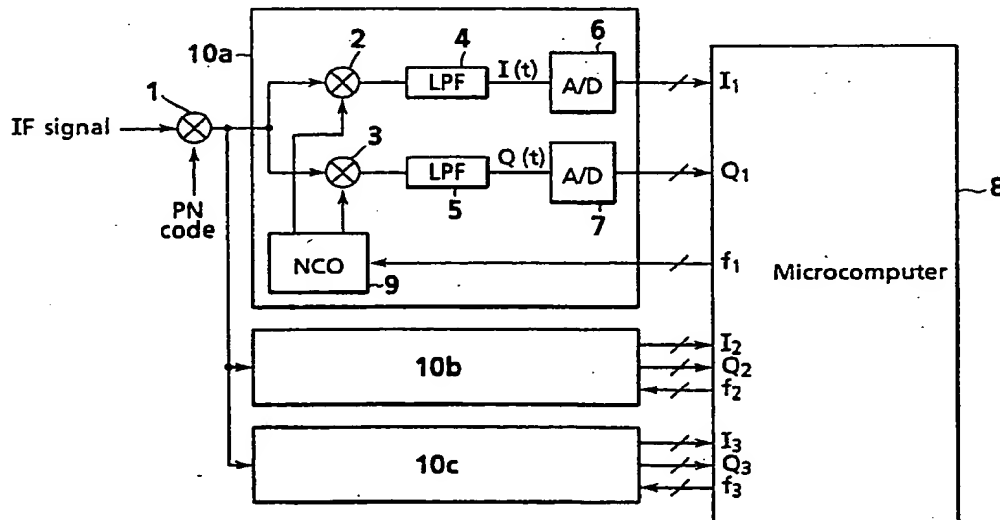
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54 GPS receiver.

57 A GPS receiver comprising a plurality of de-
modulators. A satellite transmission search range is
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modulators so that one demodulator is assigned to
one divided frequency range. Each demodulator

searches a target satellite transmission within the
frequency range assigned thereto. The GPS receiver
of this construction significantly reduces the time
required initially to capture the desired satellite
transmission.

FIG. 1



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GPS RECEIVER

BACKGROUND OF THE INVENTION:

Field of the Invention:

The present invention relates to a GPS (global position system) receiver capable of shortening the time required initially to capture satellite transmissions.

Description of the Prior Art:

Transmissions (L_1 wave) from GPS satellites are sent out at a frequency of 1575.42 MHz. Because the GPS satellites are not geostationary but orbiting satellites and because the GPS receiver is typically mounted on a moving body such as a vehicle for on-the-move signal reception, the Doppler-effect causes the receiving frequency of the transmission to fluctuate within a certain frequency range. Thus, to receive a desired satellite transmission requires changing the frequency within a predetermined satellite transmission search range in search for the target transmission, the search range covering the Doppler-shifted transmission variations.

Fig. 3 illustrates the construction of a typical prior art GPS receiver. In Fig. 3, reference numeral 1 is a multiplier for inverse diffusion; 2 is a multiplier for in-phase channel signal demodulation; 3 is a multiplier for orthogonal channel signal demodulation; 4 is a low pass filter that suppresses the harmonic component in the product from the multiplier 2 in order to obtain an in-phase channel signal $I(t)$; 5 is a low pass filter that also suppresses the harmonic component in the product from the multiplier 3 so as to acquire an orthogonal channel signal $Q(t)$; 6 and 7 are A/D converters that convert analog signals to digital format; 8 is a microcomputer for demodulation control; and 9 is a numerically controlled oscillator (NCO) controlled by the microcomputer 8.

The satellite transmission received with an antenna is converted to an intermediate frequency (IF) signal before being input to an input terminal of the multiplier 1 for inverse diffusion. Through another input terminal, the multiplier 1 admits PN code for identifying the target satellite. Maintaining the correlation between PN code and IF signal provides inverse diffusion and allows only the transmission from the target satellite to be extracted. The extracted signal is what is known as a PSK (phase shift keying) signal which is input to the multipliers 2 and 3.

The microcomputer 8 causes the NCO 9 successively to change the oscillation frequency there-

of (reproduced carrier) in increments of a certain frequency range (usually a PLL capture range) throughout the entire satellite transmission search range established in advance. The multipliers 2 and 3 are supplied respectively with an in-phase component carrier and a 90° phase shifted orthogonal component carrier, both generated by the NCO 9. The two multipliers demodulate the components. As a result, the in-phase channel signal $I(t)$ containing the harmonic component is output from the output terminal of the multiplier 2, and the orthogonal channel signal $Q(t)$ also containing the harmonic component is output from the output terminal of the multiplier 3. The two outputs pass through the low pass filters 4 and 5 wherein the harmonic component is removed from each channel signal. This leaves the in-phase channel signal $I(t)$ and orthogonal channel signal $Q(t)$ demodulated, the in-phase signal being the original base band signal.

The microcomputer 8 calculates a demodulation intensity $I^2 + Q^2$ using the in-phase channel signal $I(t)$ and the orthogonal channel signal $Q(t)$ coming from the A/D converters 6 and 7, the demodulation intensity indicating the status of satellite transmission reception at a given point in time. The frequency at which the demodulation intensity $I^2 + Q^2$ is maximized is detected as the receiving frequency f_c of the satellite transmission. The microcomputer 8 sets the oscillation frequency (reproduced carrier) of the NCO 9 to the receiving frequency f_c . Then a PLL loop is created on a software basis, the loop comprising the multipliers 2 and 3, the low pass filters 4 and 5, the A/D converters 6 and 7, the microcomputer 8, and the NCO 9. With the PLL loop established, the oscillation frequency of the NCO 9 (i.e., reproduced carrier) is locked in phase to the receiving frequency f_c .

One disadvantage of the prior art GPS receiver is that it takes considerable time initially to capture the desired satellite transmission because, as described, the search frequency is consecutively changed in increments of the PLL capture range throughout the entire satellite transmission search range in search of the target transmission.

SUMMARY OF THE INVENTION:

It is therefore an object of the present invention to provide a GPS receiver that minimizes the time required initially to capture the target satellite transmission.

In carrying out the invention, there is provided a GPS receiver comprising a plurality of demodula-

tors, wherein the satellite transmission search range is divided into as many frequency ranges as the demodulators so that one demodulator is assigned to one divided frequency range, each demodulator searching the target satellite transmission within the frequency range assigned thereto.

Because the desired satellite transmission is searched simultaneously within each of the divided frequency ranges, the time required initially to capture the transmission is reduced on average to the time with the prior art divided by the number of the partitioned frequency ranges (i.e., prior art time multiplied by 1/frequency range count).

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is a block diagram of a GPS receiver embodying the present invention;

Fig. 2 is a view illustrating how the embodiment works; and

Fig. 3 is a block diagram of the typical prior art GPS receiver.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

One preferred embodiment of the present invention will now be described with reference to the accompanying drawings.

Fig. 1 illustrates the GPS receiver embodying the invention. In Fig. 1, reference numerals 10a, 10b and 10c designate demodulators having the same construction as that of demodulators 2 through 9 in Fig. 3. This embodiment comprises three demodulators.

In implementing the invention, the entire satellite transmission search range W is divided into three frequency ranges $W1$, $W2$ and $W3$, one for each demodulator, as depicted in Fig. 2. The first, second and third frequency ranges $W1$, $W2$ and $W3$ are assigned to the first, second and third demodulators 10a, 10b and 10c, respectively. As will be described later in more detail, the demodulators 10a, 10b and 10c search the target satellite transmission simultaneously in the respective frequency ranges $W1$, $W2$ and $W3$ under control of the microcomputer 8.

How the embodiment works will now be described with reference to Fig. 2. When satellite transmissions start getting received, the microcomputer 8 establishes the lowest frequency f_1 of the first frequency range $W1$ as the search start frequency of the NCO 9 in the first demodulator 10a, the lowest frequency f_2 of the second frequency range $W2$ as the search start frequency of the NCO 9 in the second demodulator 10b, and the lowest frequency f_3 of the third frequency range $W3$ as the search start frequency of the NCO 9 in the third demodulator 10c. The oscillation frequency of each NCO 9 is consecutively changed in

increments of a PLL capture range Δf from each search start frequency upward. Thus the oscillation frequency of each NCO 9 is raised in a stepped manner within each of the frequency ranges $W1$, $W2$ and $W3$, as illustrated in Fig. 2.

A case may be assumed in which the receiving frequency of the satellite transmission is at a point f_c in the frequency range $W2$. In that case, the second demodulator 10b captures the satellite transmission when the oscillation frequency of the NCO 9 in the second demodulator 10b reaches the frequency f_c .

As evident from Fig. 2, the use of three demodulators reduces a search period T covering the entire satellite transmission search range W to one third of the period with the prior art. That is, the time required to capture the target transmission with this embodiment is reduced on average to one third of the time with the typical prior art GPS receiver. The embodiment is a significant improvement in terms of search time over the prior art GPS receiver that changes the search frequency one frequency changing step at a time throughout the entire satellite transmission search range W .

With the above-described embodiment, the frequency from which to start searching the desired satellite transmission with each demodulator is set to each of the lowest frequencies f_1 , f_2 and f_3 in the frequency ranges $W1$, $W2$ and $W3$, respectively. Alternatively, the search start frequency may be lowered in increments from the highest frequency downward. Another alternative is to oscillate the frequency in increments, up and down, around the center frequency of each frequency range. Needless to say, there may be provided any number of multiple demodulators depending on the application. Although the above embodiment uses demodulators under software control by microcomputer, this arrangement is by no means limitative of the invention. An alternative is to utilize prior art demodulators constituted by such discrete circuits as multipliers, low pass filters, loop filters and voltage controlled oscillators (VCOs).

As described and according to the invention, there is provided a GPS receiver comprising a plurality of demodulators, wherein a satellite transmission search range is divided into as many frequency ranges as the demodulators so that one demodulator is assigned to one divided frequency range, each demodulator searching a target satellite transmission within the frequency range assigned thereto. In this manner, the time required initially to capture the desired satellite transmission is significantly shortened.

It is to be understood that while the invention has been described in conjunction with a specific embodiment, it is evident that many alternatives, modifications and variations will become apparent

to those skilled in the art in light of the foregoing description. Accordingly, it is intended that the present invention embrace all such alternatives, modifications and variations as fall within the spirit and scope of the appended claims.

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Claims

1. A GPS receiver comprising a plurality of demodulators, wherein a satellite transmission search range is divided into as many frequency ranges as said demodulators so that one demodulator is assigned to one divided frequency range, each demodulator searching a target satellite transmission within the frequency range assigned thereto.

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FIG. 1

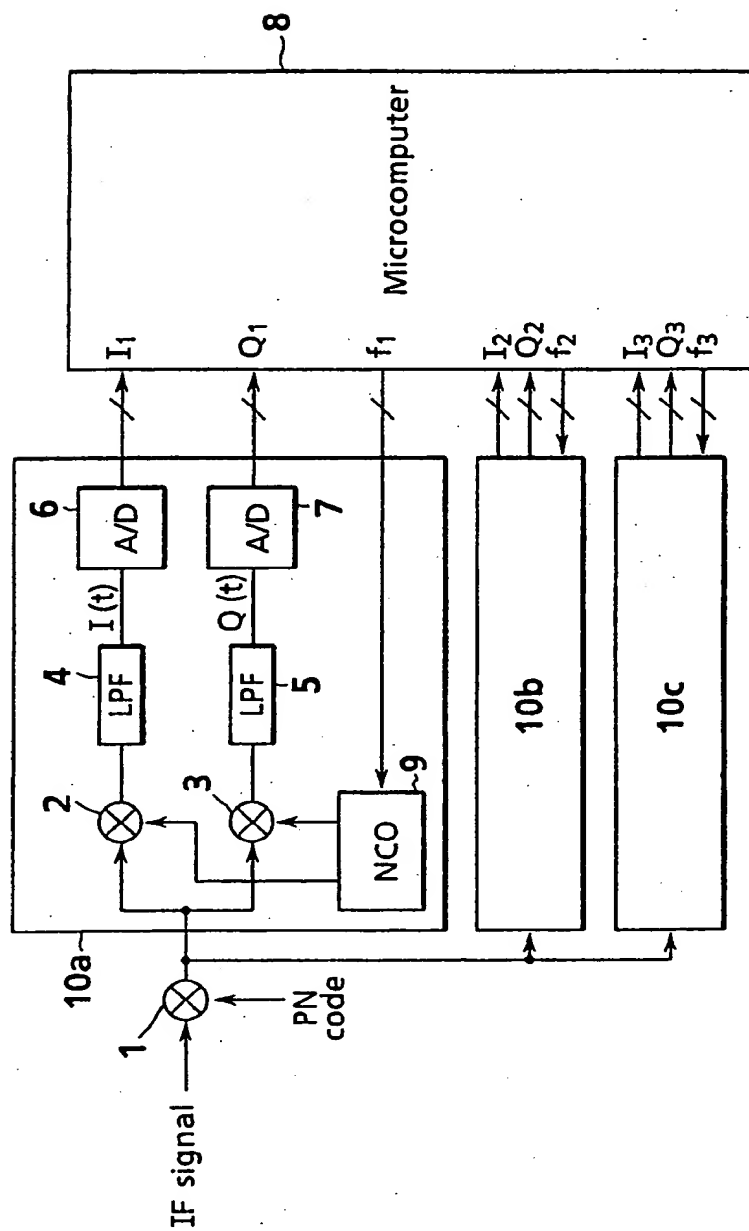


FIG. 2

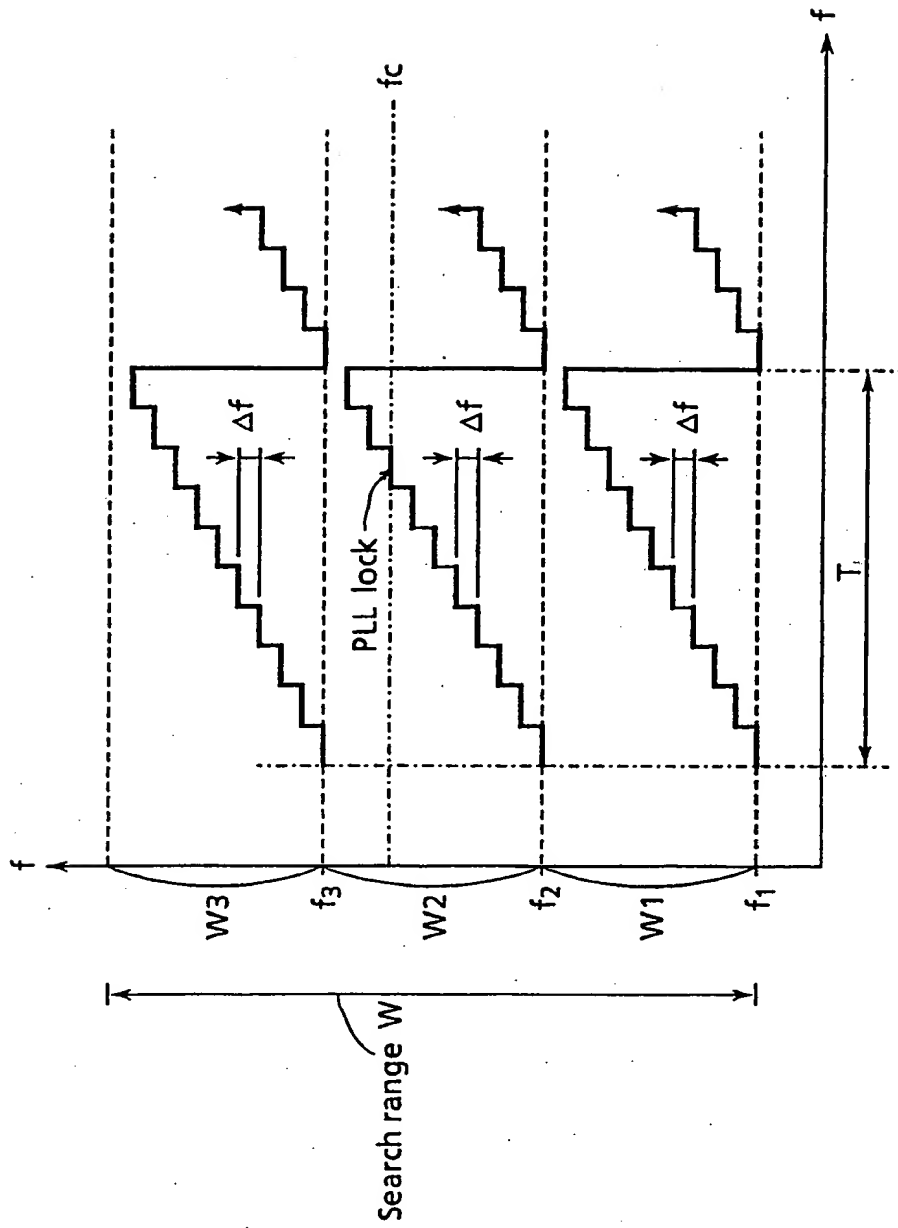
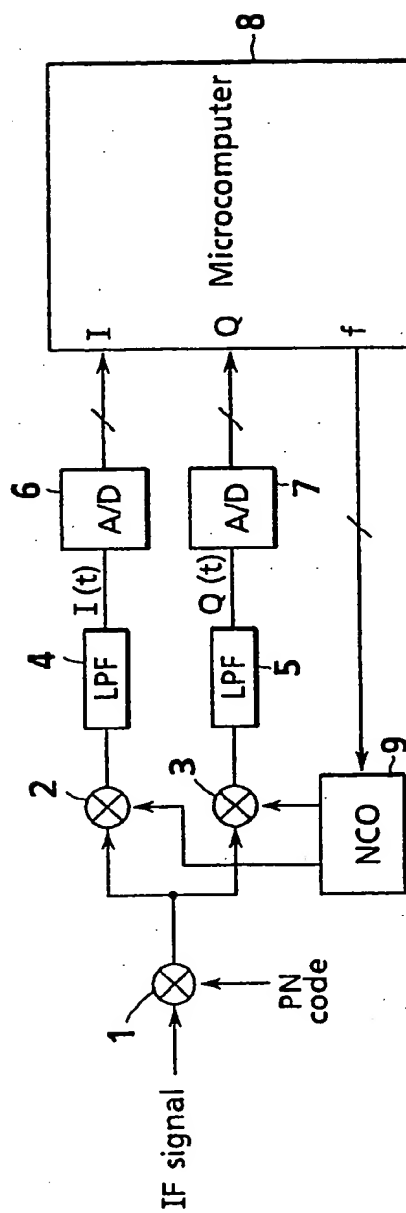


FIG. 3



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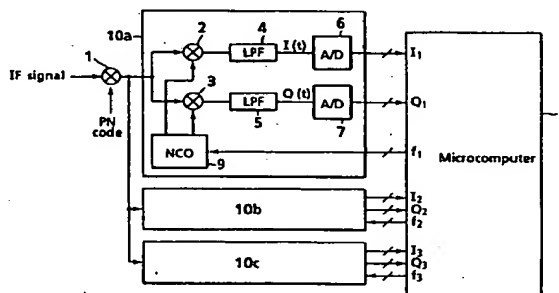
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DE FR GB(88) Date of deferred publication of the search report:
29.07.92 Bulletin 92/31(71) Applicant: **PIONEER ELECTRONIC CORPORATION**No. 4-1, Meguro 1-chome
Meguro-ku Tokyo 153(JP)(72) Inventor: **Kawasaki, Kenichiro, c/o Pioneer Electronic Corp.**Kawagoe Kojo, 25-1, Aza Nishimachi
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W-8000 München 40(DE)(54) **GPS receiver.**

(57) A GPS receiver comprising a plurality of demodulators (10a,10b,10c). A satellite transmission search range is divided into as many frequency ranges as the demodulators so that one demodulator is assigned to one divided frequency range. Each demodulator searches a target satellite transmission within the frequency range assigned thereto. The GPS receiver of this construction significantly reduces the time required initially to capture the desired satellite transmission.





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EUROPEAN SEARCH REPORT

Application Number

EP 91 10 1439

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL.5)
Y	DE-A-3 716 329 (DORNIER SYSTEM GMBH) * column 2, line 39 - line 47 * * column 2, line 65 - column 3, line 51 * * column 3, line 62 - column 4, line 34; figures 1-4 *	1	G01S5/14
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 188 (P-473)(2244) 3 July 1986 & JP-A-61 034 486 (SONY CORP.) 18 February 1986 * abstract *	1	
A	EP-A-0 351 156 (ASHTECH TELESIS INC.) * column 5, line 6 - line 44 * * column 8, line 32 - line 43; figures 1,3 *	1	
A	US-A-4 800 577 (TACHITA ET AL) * column 11, line 3 - line 40; figure 12 *	1	
A	US-A-4 578 678 (HURD) * abstract; figures 2,3 *	1	
			TECHNICAL FIELDS SEARCHED (Int. CL.5)
			G01S G01R
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 MAY 1992	Examiner HAFFNER R. D. R.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- A : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			